Available online at www.sciencedirect.com

ScienceDirect

Procedia Social and Behavioral Sciences 15 (2011) 3074–3078

Procedia Social and Behavioral Sciences

WCES-2011

Can explicit reflective approach activities about the nature of science be prepared to contribute to the overcoming of alternative concepts in the field of science subject?

Emine Çil [a] *, Salih Çepni [b]

[a] *National Ministry of Education, Cumhuriyet Primary School, Trabzon, 61300, Turkey*
[b] *Karadeniz Technical Univerity, Fatih Faculity of Education, Trabzon, 61335, Turkey*

Abstract

The aim of this study is to develop explicit reflective activities to contribute to the overcoming of alternative concepts in the field of science subject and to introduce the preparation process of these activities. In an activity called "marble", the role of imagination and creativity in science is dealt with the speed of dispersion of light which depends on the context. In the activity of "Guess what I am?" the difference between observation and deduction, the subjectivity and temporariness of the scientific knowledge are focused on. White light's covering all the colours, and the light filters' transferring itself colours which are close to itself in this activity. The prepared activities were piloted and necessary adjustments were made at the end of pilot. It was observed that activities were applicable in the class.

Keywords: Nature of Scinece, Explicit Reflective Approach, Light, Alternative Concepts

1. Introduction

One of the most important aims of science teaching is to create a literate society. The goal of all students as scientifically literate forms the centre of science curriculum reform documents of science teaching for the Association for the Advancement of Science (AAAS, 1993), the National Research Council (NRC, 1996) and a lot of individual countries (England, The USA, Canada, Australia and Turkey). The nature of science is handled as the most important component of scientific literacy. Although consensus of views is not reached on the definition of the nature of science, the aspects of the nature of science that the students at the K-12 level acquire are determined in the reform documents of science teaching and the studies conducted in this field. The studies conducted revealed that the students at different learning levels, the teachers and the prospective teachers had naive/inadequate view of the nature of science, and they had myths (McComas, 2000; Khishfe & Abd-El-Khalick, 2002; Akerson, Morrison & Mcduffie, 2006; Irez, 2006).

Not being able to understand the nature of science enough has brought up how the nature of science can be taught effectively and what the factors that prevent the teaching of nature of science are. Implicit, explicit reflective and historical approaches are the three basic approaches that are used in teaching the nature of science. In a lot of studies

* Emine Çil. Tel.: 505 825 88 62
E-mail address: enimeonyedi@hotmail.com

1877–0428 © 2011 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
doi:10.1016/j.sbspro.2011.04.248

conducted by Lederman and his team, it was determined that the explicit reflective approach was the most effective method for the teaching of nature of science. The explicit reflective approach accepts the nature of science as a product of cognitive learning. It defends that the class environments where the students work as a scientist to understand the nature of science are not enough and that the elements of nature of science must be discussed explicitly with the specifically prepared activities such as the concepts, principles, theories and laws in the field of science. Furthermore, the teaching practises in different grades of learning from the primary school to university which still give importance to the teaching of the subject, where problem solution and the skills of scientific process stand in the forefront, and which doesn't give importance to the qualities of scientific knowledge and how it is developed are reported in the literature (Karakaş, 2009; Kattoula et.al., 2009). In this context, it can be said that the activities of explicit reflective approach of nature of science which not only hinder the teaching of subject in science courses but also contribute to the overcoming of alternative concepts in the field of science are needed. The explanation of development process of such activities can lead the teachers to prepare their own materials in different fields. The aim of this study is to develop explicit reflective activities to contribute to the overcoming of alternative concepts in the field of science subject within the context of the light unit at the 7th grade elementary level. This was introduced during the development of the activities and the piloting process of the implementation.

2. Method

The activities of explicit reflective approach of nature of science were developed by following the steps given below.

1. The aspects of nature of science which the students at primary school could learn were determined by examining the studies conducted in the field of nature of science and the curriculum of Science and Technology. It was decided that the aspects of differences between the temporary, imagination and creativity, subjectivity, observation and deduction of nature of science were to be discussed with the activities to be developed. The activities of explicit reflective approach which are used frequently in the literature were analyzed. Therefore, knowledge about the qualities which are going to be present in the activities to be developed was obtained.
2. Because teaching of nature of science was realized during teaching of science topics within the contentt of Science and Technology education in Turkey, a topic to prepare activities was determined. When the literature was analysed, the topics of atom theories, evolution theory, global warming and gravitational mass law drew attention in teaching of nature of science because of being used frequently. It was emphasised in the literature that the students, the teachers and teacher candidates have alternative concepts about light and light is a difficult topic to learn (Galili & Hazan, 2000; Chang et. al., 2007; Yalçın et.al., 2009). Therefore, it was decided that the activities of nature of science were prepared in the 7th grade and about light.
3. The target goals of light unit of the education programs of Science and Technology of the 7th grade in secondary education was considered at length. The potential alternative concepts likely to be present with the students which are to be acquired in the unit were determined .The answer to the question of which aspect of nature of science is to be handled with which alternative concept was sought. Both the imaginative and creative elements of nature of science in the activity called "Marble" which was presented within the context of the study and the alternative concept which says "the speed of light never changes" in the subsection of Light Unit called as breaking of light are dealt with. The students experiment experiences such as the scientists use their creativity and imagination in their studies over the change in the light's speed of diffusion depending on the environment with the example of the decrease in the speed of diffusion of light beams while passing through from air to water. The activity called "Guess what I am?" focus on the temporary, subjective and deductive aspects of nature of science. Moreover, the activity is likely to contribute to the overcoming of alternative concepts related to white and light filters in the subsection of colourful appearance of the objects of the Light Unit. The students obtain the experiences related to these aspects of nature of science in the activity over the white light contains all colours, the light filters do not give colour to the light, and the filters pass the same tones of light from the coming light behind.
4. The drafts of the activities were prepared and presented to the views of the experts. The views of the experts contributed to whether the activities prepared were appropriate to to the philosophy of explicit reflective approach in teaching of nature of science and scientific facts in terms of both to the aspects of nature of science and the light topic.

5. Nature of science activities were revised according the feedback of experts. The experts believe that the activities created for the study were compatible with the explicit reflective approach philosophy. They emphasised that the teacher should deal with the elements of the nature explicitly and intentionally in the approach's explicit section. They also stated that reflection means that the students can explain what they have learned about the aspects of the nature of science and can put forward their views. It was suggested that some precautions should be taken in order not to ignore the reflective part of the explicit reflective approach in the classroom. The section "Let's Get to a Conclusion" was added to the activities in the light of these suggestions.
6. The teacher who implemented the activities was informed about the nature of science, approaches used in the teaching of the nature of science and how to use the activities.
7. The piloting of the activities prepared was done with the participation of 22 students in 2008-2009 education year. The activities were revised by the feedback gained from the piloting. For example, it was determined that a big glass marble was required to be used during the piloting process in "marble" activity. Moreover, the students being able to observe the incident better drew the attention in case of putting water and sand one day ago and resting it for a night in this activity. It was determined that there were questions which the students couldn't understand in Guess what am I?" activity. For example, the students couldn't understand the deduction concept. The questions were rewritten so that the students could understand them. Therefore, the activities were finalized.
8. The real practice of the activities was carried out in 2009–2010 education year.

2.1. Introduction of the Activities

The activities are formed in three parts. The general structures of the activities were explained by the sample given below.

Part 1: The activities start with a question asked to the students or a condition which the students generate ideas about its possible reasons. In this section, the aim is to attract the attention of the students and to arouse their pre-knowledge. The first part of the marble activity is performed below.

In the adjoining figure, light beams pass through from air to water. In this condition, which of the following statements given below are true for the light's speed of dispersion? Why?
a) The light's speed of dispersion is the same both in the air and the water.
b) The light's speed of dispersion in the air is greater than its speed of diversion in the water.
c) The light's speed of dispersion in the water is greater than its speed of diversion in the air.

Part 2: The activities about the subject whose attention was drawn upon are carried on by the practises such as the experiment, discussion, interpretation of picture, and so on. The discovery of the points whose attention was drawn in Part 1 was provided here. The second part of the marble activity is performed below.

What to use? A big glass marble sand, fibre (sponge), water, scissors and glass bowl.
How to do?
1. Put some sand on the bottom of the glass bowl.
2. Add water on the sand. (Let's have the mixture of water-sand rest for some time.)
3. Cut the fibre (sponge) into small pieces.
4. Place the cut pieces of fibre or sponge on the water in the glass bowl.
5. Leave (drop) the marble at a particular height into the glass bowl. Observe the movement of the marble in the three different environments.

Part 3: There are questions present in this section about the aspect of nature of science which was experienced in the activity and the target goals of light unit which was studied. After the students answered the questions individually, the activity ended up with a class discussion. Below is given "Let's Get to Conclusion" section of the "marble" activity.

Let's Get to Conclusion
1. Let's compare the marble to a light, the sand environment to glass, water to water and the environment the sponge pieces present to air. In this condition, in which environment does the light move the fastest?
2. Were you able to calculate the speed of light in different environments as mathematically?
3. How can you explain the speed of light in different environments in association with the granular structure of the matter?
4. Can the scientists use their imagination and creativity in their studies? Explain by giving examples.
5. In which stage of their studies can the scientists use their imagination and creativity?

3. Conclusion and Suggestions

The activities of explicit reflective approach of nature of science which were prepared in the context of the study were developed according to the points explained in the literature. For instance, one of the most important points of the explicit reflective approach philosophy is that the aspects of nature of science were studied with the specially designed and planned activities such as science topic. To which target goals of the unit the activities are going to be practised in compatible with, which aspects of the nature of science are going to be studied besides the target goals about light in the activity, during the teaching of nature of science which part of the activity aims at realising which objective were determined before the questions which were going to be asked to the students in this study. The teacher training was performed on the verge of how the activity was going to be practised and what the teacher and the students were expected to do at what stage. The teaching of nature of science's being with or without in the context of the field of science was a subject of discussion in the literature. Khishfe & Lederman (2006) determined that the practise of explicit reflective approach with or without in the context of the field of science was not important. Because subject field and the skills of scientific process were emphasized in the education of science in the schools (Karakaş, 2009; Kattoula et.al., 2009), the activities were prepared in order to be able to serve these objectives. For example, it was aimed to support the subject field teaching with the activities' being totally in compatible with the target goals of light unit and the development of the skills of scientific process with the experiments within the second part of the activities. Moreover, another strong point of the activities is that the activities frequently overlapped with the target goals of alternative concepts which the students have. The applicability of the activities by the teachers in the classes were tried to be raised with all these practises. Another important point of explicit reflective approach is that the students had reflections about the aspects of nature of science which they acquired. The fundamental aim of the "Let's Get to Conclusion" sections of the developed activities is to provide the students to have connections between the activities they did and the studies of the scientists. The first and the last parts of the activities require the students to be mentally active while the second parts of the activities require them to be physically active. In this context, it can be said that the activities were compatible with the student centred educational practises. It was observed in the real practise which was conducted that the activities could be applicable in the class environment. Only the activities which were developed were introduced in this study but their effects were not analysed. The effects of the activities on the teaching of nature of science and the alternative concepts which they were related to about light can be evaluated in the future studies.

References

AAAS. (1993). American Association for the Advancement of Science, Project 2061, Benchmarks for Science Literacy, Oxford University Press, New York.

Akerson, V. L., Morrison, J. A., & McDuffie A. R. (2006). One Course Is Not Enough: Preservice Elementary Teachers' Retention of Improved Views of Nature of Science, *Journal of Research in Science Teaching,* 43, 194–213.

Chang, H-P., Chen, J-Y., Guo, C-J., Chen, C-C., Chang, C-Y., Lin, S-H., Su, W-J., Lain, K-D., Hsu, S-Y., Lin, J-L., Chen, C-C., Cheng, Y-T., Wang, L-S., & Tseng, Y-T. (2007). Investigating Primary and Secondary Students' Learning of Physics Concepts in Taiwan, *International Journal of Science Education,* 29, 465–482.

Galili, I., & Hazan, A. (2000). Learners' knowledge in optics: interpretation, structure and analysis, *International Journal of Science Education,* 22, 57- 88.

Irez, S. (2006). Are We Prepared?: An Assessment of Preservice Science Teacher Educators' Beliefs About Nature of Science, *Science Education,* 90, 1113-1143.

Karakaş, M. (2009). Cases of Science Professors' Use of Nature of Science, *Journal of Science Education and Technology.,* 18, 101–119.

Khishfe, R., & Abd-El-Khalick, F. (2002). Influence of Explicit and Reflective versus Implicit Inquiry-Oriented Instruction on Sixth Graders' Views of Nature of Science, *Journal of Research in Science Teaching,* 39, 551–578.

Khishfe, R., & Lederman, N. (2006). Teaching Nature of Science within a Controversial Topic: Integrated versus Nonintegrated, *Journal of Research in Science Teaching,* 43, 395–418.

Kattoula, E., Verma, G., & Martin-Hansen, L. (2009). Fostering Preservice Teachers' "Nature of Science" Understandings in a Physics Course, *Journal of College Science Teaching,* September/October, 18- 26.

McComas, W.F. (2000). The Principal Elements of The Nature of Science: Dispelling The Myths. In B. W. F. McComas (ed.) The Nature of Science in Science Education, Rationales and Strategies (pp. 53–70). Dordcrecht, The Netherlands: Kluwer Academi.

NRC (1996). National Science Education Standards, National Academy Press. Washington D.C.

Yalçın, M., Altun, S., Turgut, Ü., & Aggül, F. (2009). First Year Turkish Science Undergraduates' Understandings and Misconceptions of Light, *Science & Education,* 18, 1083–1093.

Appendix 1 Activity: Do you know what I am??

How the red and green colours of traffic lights are acquired? Please explain it below.

.....

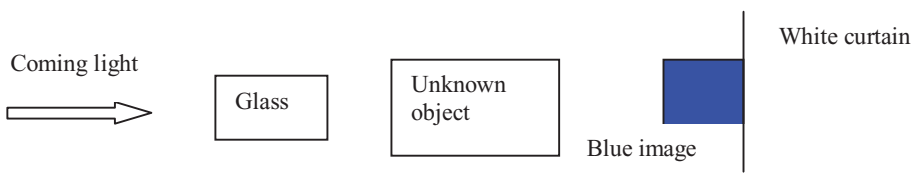
What to use? Torch (3 pieces), red, green and blue cellophane paper, a rubber band, a white paper (Do the activity in a dark room)

How to do?

1. Place the red, green and blue cellophane papers in front of the torches as two folds and fix them with a rubber band.
2. After having the torches in working condition in taking turns, observe them by holding them onto a white paper.
3. Have the three torches in working condition. Observe by superposing the three colours on the white ground.

Let's Get to Conclusion

1. Which colours did you observe on the white ground with the activity explained above?
2. What did you observe when the three colours were superposed?
3. What is the function of the cellophane used in the activity?
4. Answer the questions given below according to the figure?



The light which is formed by the unknown colours firstly passes through glass and then an object which is unknown. A blue image appears on the curtain which is at the furthest back, so what can be the colour of the coming light and the unknown object? Write your guesses on the boxes in the figure.

a) As it is given above in the figure, what are the things which you perceive by your senses and make sure about their existence concretely?

b) What did you conclude according to the clues you have by close reasoning although you haven't been able to observe in the activity?

c) Are there any different ideas in the class about the colour of the coming light and what the unknown object is? Although the scientists have the same data about a subject, can they reach different conclusions? Explain by giving examples.

d) Are you sure about the colour of the coming light and the object in front of the curtain? Can scientific knowledge always introduce absolute facts?